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Date of Filing : 26 APR 2004

Application Number : PCT/SG2004/000109

Applicant(s) /
Proprietor(s) of Patent : TREK 2000 INTERNATIONAL LTD

Title of Invention : PORTABLE DATA STORAGE DEVICE
WITH ENCRYPTION SYSTEM


Chig Kam Tack (Mr)
Senior Assistant Registrar
for REGISTRAR OF PATENTS
SINGAPORE

21 Feb 2005

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REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

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PCT/SG 2004 / 000109	
International Application No.	
126 APR 2004 (26-04-2004)	
International Filing Date	
REGISTRY OF PATENTS (SINGAPORE) PCT INTERNATIONAL APPLICATION	
Name of receiving Office and "PCT International Application"	
Applicant's or agent's file reference (if desired) (12 characters maximum) FP2241	

Box No. I TITLE OF INVENTION	
PORTABLE DATA STORAGE DEVICE WITH ENCRYPTION SYSTEM	
Box No. II APPLICANT <input type="checkbox"/> This person is also inventor	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)	
Trek 2000 International Ltd. 30 Loyang Way #07-13/14/15 Loyang Industrial Estate Singapore 508769	
Telephone No.	
Facsimile No.	
Teleprinter No.	
Applicant's registration No. with the Office	
State (that is, country) of nationality: SG	State (that is, country) of residence: SG
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OOI, Chin Shyan Raymond Blk 438 Tampines St. 43 #08-157 Singapore 520438	
This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only (If this check-box is marked, do not fill in below.)	
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Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)	
WATKIN, Timothy Lawrence Harvey Lloyd Wise Tanjong Pagar P O Box 636 Singapore 910816	
Telephone No. 65 6227 8986	
Facsimile No. 65 6227 3898	
Teleprinter No.	
Agent's registration No. with the Office	
<input type="checkbox"/> Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.	

Sheet No. ...2...

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LIM, Lay Chuan
Blk 322 Bukit Batok St. 33 #03-04
Singapore 650322

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office

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State (that is, country) of residence:

SG

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POO, Teng Pin
Blk 44 Bedok South Road #11-763
Singapore 460044

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office

State (that is, country) of nationality:

MY

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TAN, Henry
1 Palm Drive
Singapore 456458

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

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State (that is, country) of nationality:

SG

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The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

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(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office) identified above as:

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

* Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

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Box No. VIII DECLARATIONS

The following declarations are contained in Boxes Nos. VIII (i) to (v) (mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):

Number of
declarations

- | | | |
|---|--|---|
| <input type="checkbox"/> Box No. VIII (i) | Declaration as to the identity of the inventor | : |
| <input type="checkbox"/> Box No. VIII (ii) | Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent | : |
| <input type="checkbox"/> Box No. VIII (iii) | Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application | : |
| <input type="checkbox"/> Box No. VIII (iv) | Declaration of inventorship (only for the purposes of the designation of the United States of America) | : |
| <input type="checkbox"/> Box No. VIII (v) | Declaration as to non-prejudicial disclosures or exceptions to lack of novelty | : |

Box No. IX CHECK LIST; LANGUAGE OF FILING		
<p>This international application contains:</p> <p>(a) in paper form, the following number of sheets:</p> <p>request (including declaration sheets) : 4</p> <p>description (excluding sequence listing and/or tables related thereto) : 15</p> <p>claims : 5</p> <p>abstract : 1</p> <p>drawings : 3</p> <p>Sub-total number of sheets : 28</p> <p>sequence listing : :</p> <p>tables related thereto : :</p> <p><i>(for both, actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (c) below)</i></p> <p>Total number of sheets : 28</p> <p>(b) <input type="checkbox"/> only in computer readable form (Section 801(a)(i))</p> <p>(i) <input type="checkbox"/> sequence listing</p> <p>(ii) <input type="checkbox"/> tables related thereto</p> <p>(c) <input type="checkbox"/> also in computer readable form (Section 801(a)(ii))</p> <p>(i) <input type="checkbox"/> sequence listing</p> <p>(ii) <input type="checkbox"/> tables related thereto</p> <p>Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the</p> <p><input type="checkbox"/> sequence listing:</p> <p><input type="checkbox"/> tables related thereto:</p> <p><i>(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)</i></p>	<p>This international application is accompanied by the following item(s) <i>(mark the applicable check-boxes below and indicate in right column the number of each item)</i>:</p> <p>1. <input checked="" type="checkbox"/> fee calculation sheet : 1</p> <p>2. <input type="checkbox"/> original separate power of attorney : :</p> <p>3. <input type="checkbox"/> original general power of attorney : :</p> <p>4. <input type="checkbox"/> copy of general power of attorney; reference number, if any: : :</p> <p>5. <input type="checkbox"/> statement explaining lack of signature : :</p> <p>6. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s): : :</p> <p>7. <input type="checkbox"/> translation of international application into (language): : :</p> <p>8. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material : :</p> <p>9. <input type="checkbox"/> sequence listing in computer readable form (indicate type and number of carriers)</p> <p>(i) <input type="checkbox"/> copy submitted for the purposes of international search under Rule 13ter only (and not as part of the international application) : :</p> <p>(ii) <input type="checkbox"/> (only where check-box (b)(i) or (c)(i) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Rule 13ter : :</p> <p>(iii) <input type="checkbox"/> together with relevant statement as to the identity of the copy or copies with the sequence listing mentioned in left column : :</p> <p>10. <input type="checkbox"/> tables in computer readable form related to sequence listing (indicate type and number of carriers)</p> <p>(i) <input type="checkbox"/> copy submitted for the purposes of international search under Section 802(b-quater) only (and not as part of the international application) : :</p> <p>(ii) <input type="checkbox"/> (only where check-box (b)(ii) or (c)(ii) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Section 802(b-quater) : :</p> <p>(iii) <input type="checkbox"/> together with relevant statement as to the identity of the copy or copies with the tables mentioned in left column : :</p> <p>11. <input checked="" type="checkbox"/> other (specify): .PF48..... : 1</p>	<p>Number of items</p>
<p>Figure of the drawings which should accompany the abstract: 1</p>	<p>Language of filing of the international application: ENGLISH</p>	
<p>Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE</p> <p><i>Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).</i></p>		
<p style="text-align: center; font-size: 1.5em;">Timothy Wark</p> <hr style="border: 0; border-top: 1px dashed black; margin: 5px 0;"/> <p style="text-align: center;">WATKIN, Timothy Lawrence Harvey Agent for the Applicant</p>		

For receiving Office use only		<p>2. Drawings:</p> <p><input type="checkbox"/> received:</p> <p><input type="checkbox"/> not received:</p>
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PCT

FEE CALCULATION SHEET

Annex to the Request

For receiving Office use only

PCT/SG 2004/000109

International Application No.

26 APR 2004

Applicant's or agent's
file reference

FP2241

Date stamp of the receiving Office

Applicant

Trek 2000 International Ltd.

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE \$150 T

2. SEARCH FEE \$310 S

International search to be carried out by AT
(If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)

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i1 first 30 sheets \$1926 i1

i2 number of sheets in excess of 30 x fee per sheet = i2

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Portable Data Storage Device with Encryption System

Field of the invention

The present invention relates to a portable data storage device of the kind having a non-volatile solid state memory. In particular it relates to such a
5 device having encryption capability.

Background of Invention

Recently there have been much development in the area of portable data storage devices having non-volatile solid state memory units, such as flash
10 memories. A seminal patent application in this area, PCT/SG00/00029, "Portable Data Storage Device", describes a memory device which can be directly plugged into the socket of a computer using an integral male USB plug. The size of the device is such that it is capable, for example, of being fully enclosed within a closed fist, and is in this sense portable. It is able to
15 receive data from one computer system, and transfer it to another computer system, just like a magnetic disk or CD-RW disk.

Many improvements of this scheme have been proposed. For example, PCT/SG02/00047, describes a portable data storage device in which access
20 to the data in the non-volatile memory device is only permitted to users whose identities have been verified by an integral biometrics sensor, such as a fingerprint sensor.

PCT/SG02/00086 describes that a portable data storage device can include
25 an engine for compressing data and decompressing data, so that the effective data storage capacity of the device (i.e. the amount of typical user data which the device can receive and regenerate) is greater than the nominal capacity of the non-volatile memory device.

Singapore patent application no. 200400358-8 describes a portable data storage device which is adapted for storage of data describing video images, such that the device can be used to a video generation system to play video.

5

PCT/SG01/00136 describes a portable data storage device which is arranged for wireless communication with a host, e.g. by radio, for receiving data and subsequently regenerating it. The device is thus capable of transferring data between computer systems which are capable of this wireless data

10 transmission. PCT/SG03/00152 describes an enhancement of this system in which the data storage device includes a pointer, so that it can a user can move it to act as a convenient data input device.

PCT/SG03/00033 describes a portable data storage device which is arranged
15 to receive data securely from an information provider or the Internet. This may use a public key associated with the user and pre-stored in the device.

The disclosure of all of the above references is incorporated herein in its entirety.

20

Summary of the Invention

While many of these documents provide a convenient portable data storage device, there remain concerns about security. For example, if the device falls into the hands of a person with equipment for measuring and modifying
25 electrical signals being transmitted between the device and the host, there is concern that data transmitted out of the device could be modified before it reaches the host.

The present invention aims to provide a new and useful portable data storage device, and in particular one which may be able at partially to alleviate this problem.

In general terms, the invention proposes a portable data storage device
5 having a non-volatile memory for storing user data, an interface section for receiving and transmitting data to a host, and a master control unit for transferring data to and from the non-volatile memory. Upon a command from a host requesting data, the device transmits the requested data stored in its memory to the host using the interface section. The device further includes an
10 integrated circuit means for generating at least one key, and that the portable data storage device is arranged to transmit the key to the host.

In a first application of the invention, the generated key is transmitted in an encrypted form. The generated key is encrypted using a secret key which is not generated by the integrated circuit means but permanently stored in the
15 portable storage device. The portable storage device transmits the encrypted generated key to the host. The host is additionally arranged to store the secret key, and use it to decrypt the encrypted generated key. It then uses the generated key and the requested data to generate a digital signature. The digital signature is transmitted to the portable storage device which verifies
20 that it was generated using the data. Thus, the device is able to verify the integrity of the data received by the host.

No third party is able to interfere with this process (e.g. by controlling the signals transmitted out of the portable memory device, or signals transmitted into it) since without access to the secret key he cannot regenerate the private
25 key, and without access to the private key he has no means of generating the digital signature. The fact that the private key is different each time the data is transmitted means, for example, that the digital signature transmitted from the host to the portable data storage device following a first transmission of the

data cannot just be recorded and transmitted subsequently to the portable storage device, since it only has validity once.

- Optionally, the generation of the digital signature using the data and the private key includes first hashing the data to generate a hash result, and
- 5 encrypting the hash result using the generated key.

Optionally, the data can be transmitted from the portable data storage device in an encrypted form. Conveniently, it is encrypted using the generated key and/or the secret key, but alternatively (or additionally) it may be encrypted in some independent way.

- 10 Typically, the generated key is the private key of a public key/private key pair. The verification of the digital signature may optionally be performed in the device using the public key.

- In a second application of the invention, the portable data storage device is capable of generating two keys: a public key and a private key. In this case,
- 15 the device generates a digital signature using the requested data and the private key, and transmits the digital signature and the public key out of the device. The host uses the public key to verify that the requested data it receives is the same data which the device used to generate the digital signature.

- 20 Optionally, the requested data extracted from the memory may be supplemented with other data (such as biometric data obtained from a biometric sensor of the device).

- Embodiments of the present invention may incorporate any one of more of the features of the data storage devices described in the "background" section of
- 25 this application.

In particular, they preferably include a biometric sensor and verification engine (possibly a portion of the master control unit) for granting access to data stored in the device based on a biometric verification of the user's identity. Optionally, biometric data received from the biometric sensor may be included
5 in data transmitted out of the device (preferably in encrypted form). Optionally, the fingerprint may be generated from data including the biometric data.

Furthermore, the device preferably include a compression algorithm for exploiting any redundancy in data received by the device to compress it before storing it in the non-volatile memory, and a decompression engine to
10 regenerate the data before it is transmitted from the device.

Furthermore, the interface section of the device may be a USB connection, e.g. using a USB plug integral with the memory device (which itself is formed as one physical unit), or a wireless data connection.

The housing of the device may have any physical shape, such as one
15 including a narrowed end for use as a pointer.

The device may further include a camera for generating image data, and/or a microphone for capturing audio sound. The image and/or audio data may be stored in the memory, prior to being transferred to the host.

The invention may be expressed either as a data storage device (e.g. in
20 combination with a host), or as a method performed jointly by a data storage device and host.

Brief Description of The Figures

Preferred features of the invention will now be described, for the sake of illustration only, with reference to the following figures in which:

25 Fig. 1 shows the overall construction of a device which is an embodiment of the invention;

Fig. 2 shows the steps of a first method performed by the device of Fig.1; and

Fig. 3 shows the steps of a second method performed by the device of Fig. 1.

5

Detailed Description of the embodiments

Fig. 1 shows the general form of a portable data storage device which is an embodiment of the invention. The device is typically formed as an integral unit within a housing. It comprises a master control unit 1, a non-volatile memory unit 3 (typically, a flash memory comprising one or more flash memory units), and a biometric sensor 5 such as a fingerprint sensor. It further comprises a data transmission/reception section 7, for communication with an external host (such as a personal computer, or other computing system).

15

The data transmission/reception section 7 may take many forms. In one form, it comprises a USB connector 9 (such as a USB plug) and a USB interface device 11 between the USB connector 9 and the master control unit 1. Preferably, the interface device 11 and connector 9 operate according to the USB 2.0 standard, or any faster standard which may be developed in the future. The USB connector 9 may for example be a male USB plug integrally formed with the rest of the memory device of Fig. 1, for direct insertion (i.e. without a cable in between) into a female socket of the host. More generally, the connector 9 may be any other form of male connector for insertion into a socket, such as a Firewire plug.

25

Alternatively, the section 7 may be provided as a section for wireless data transmission/reception to the host (e.g. without physical contact of the memory device and the host). In this case it may the plug 9 is replaced by an antenna, and the interface device 11 is replaced by a device for using the

30

antenna for wireless transmission/reception of data. For example, these two units may function together to provide an interface according to a wireless standard, such as WLAN or Bluetooth.

5 In any case, the master control unit 1 is arranged to receive data packets from the section 7. These data packets may include commands, and also may include data (possibly in an encrypted form as described below). According to the commands, the master control unit 1 stores the data in the memory 3. The location within the memory 3 in which the data is stored is determined by the
10 master control unit 1 in accordance with commands. Furthermore, according to commands received by the master control unit 1, the unit 1 may instruct the memory 3 to transmit data stored in it to the master control unit 1, which may use at least some of the data to generate packets including the data (preferably in an encrypted form, as described below), and transmit them out
15 of the device through the section 7.

The memory 3 preferably has a data storage capacity of at least 32MB or at least 64MB, and more preferably higher, such as at least 128MB, at least 256MB, at least 512MB, or at least 1GB.

20

The master control unit is normally a programmable integrated circuit which operates based on software it downloads (normally during start-up) from a ROM memory (not shown) of the device, and/or possibly from the non-volatile memory 3.

25

As described in PCT/SG02/00047, the biometric sensor 5 receives biometric data (e.g. a fingerprint) from an individual who is a user of the device, and identifying that individual. The MCU 1 may only operate if the biometric data matches pre-stored data located within the device, such as stored in the
30 memory 3.

The device further includes an integrated circuit means 13 (which may, as shown, be a single integrated circuit ("smartcard"), or which in some embodiments of the invention be implemented using multiple physically
5 separate integrated circuits co-operating to function as a single integrated circuit) for generating a pair of asymmetrical PKI (public key infrastructure) encryption keys: a private key (denoted here as K) and a public key (denoted here as Z). It does this on the instructions of the master control unit 1, and transmits the keys generated to the master control unit.

10

The integrated circuit 13 may be a known "smartcard"; that is, it may be according to designs which are known in the field of credit card security for example. The various security features of such cards may be present in the integrated circuit 13. For example, the integrated circuit 13 is preferably
15 implemented in a tamper-proof fashion, such that any attempt to interfere with it (e.g. to access a secret key stored within it, or to influence the generation of the keys) is liable to make the integrated circuit 13 (and hence the device) inoperative.

20

Normally, the integrated circuit 13 includes a random number generator unit, such that the pair of keys will be different each time they are generated according to the differing random output of the random number generator.

25

The device further stores within it a predetermined "secret key", denoted here as "I". This may be stored for example, in the memory 3. Alternatively, it may be stored in the integrated circuit 13. At any rate, the key is preferably stored such that it is very difficult to extract from the device without making the device inoperative..

We now turn to describing four modes of operation of the device. Note that certain devices which are embodiments of the invention will be capable of performing all these modes of operation, while other devices which are embodiments of the invention are only capable of performing one of them.

5

Note that these modes of operation are described, for the sake of simplicity, without reference to the concept mentioned above of verifying user identity using the biometric sensor 7. However, it is to be understood that any of the processes described above may optionally include steps (e.g. after data is requested from the device) in which biometric data is input to the biometric sensor 7, and the identity of that data with biometric data pre-stored in the device is checked, before the device performs any further steps of the process.

15 1. Verification by device of data received by the host

In this mode of operation, the device is able to transmit data to a host which has access (e.g. within itself or its own resources) to the secret key, and to verify that the host has received the data correctly.

20

The steps of this procedure are as follows, and as shown in Fig. 2.

In a first step, the host signals to the device that it wishes to receive data ("requested data", denoted here as A) stored in the memory 3 (step 1). In response, the MCU 1 instructs the integrated circuit 3 to generate a public key Z and a private key K (step 2).

25

The MCU 1 then encrypts the private key K using the secret key i and transmits the encrypted private key K to the host (step 3). The device further

transmits the data requested by the host (step 4). Note that this requested data may optionally be encoded by the MCU before it is transmitted to the host, e.g. using the public key Z. This can be done in various ways, such as by a symmetric encryption (e.g. using i), or using the private key K. One
5 preferred possibility is to generate second set of public/private keys, transmit the second private key to the host encoded (e.g. using i) such that the host can decode it, and then transmitting the data encoded using the second public key such that the host can decrypt it using the second private key.

10 Note that the secret key i is not transmitted out of the device.

In step 5, the host decodes the private key K using the secret key i it already knew. In the case that the requested data was encrypted using the public key Z, the host decodes it using K.

15

In step 6, the host uses the decrypted private key K and the requested data set to generate a digital signature. Preferably this is done by the sub-steps of generating a hashed version of the requested data (step 6.1) to produce a hash result (denoted here as A'), and using the private key K to encode the
20 hash result (step 6.2) as a digital signature.

In step 7, the digital signature is transmitted by the host to the device.

In step 8, the device (normally the MCU 1) verifies the digital signature using
25 the requested data A. One way of doing this is for the device to hash A to produce A' (step 8.1), and decrypt the digital signature using the public key Z to produce a result called B' (step 8.2), and verify that A' is equal to B' (step 8.3).

(An alternative way to verify the digital signature would be for the device to use the requested data A and the private key K to produce its own version of the digital signature, and verify that this is identical with the digital signature received from the host). Note that in this variant the public key Z is never
5 used. This means that the invention can be performed even if the private key K is not part of a public/private key pair, but rather is a key used for symmetric encryption.

If there is no match, then the host has not correctly received the data and/or
10 the private key, and the device then implements (step 9) an appropriate transmission failure procedure, which may include sending a warning message to the host, and/or disabling its own operation, at least for a predetermined time.

15 Note that the order of some of the steps in Fig. 2 can be changed without altering the overall operation significantly.

For example, step 8.1 may optionally be performed as soon as the requested data enters the device, and the hash result A' may be stored in the memory 3.
20 This means that the hashing operation only has to be performed once, rather than whenever the data A is requested.

2. Verification by the host of data received from the device

25 In this mode of operation, the device is able to transmit data to a host (not necessarily one having access to the secret key), and the host is able to verify that it has received the data correctly.

The steps of this procedure are as follows, and as shown in Fig. 3.

In a first step, the host signals to the device that it wishes to receive data ("requested data", denoted by A) stored in the memory 3 (step 1). In response, the MCU 1 instructs the integrated circuit 3 to generate a public key Z and a private key K (step 2).

5

In step 3, the device (normally the MCU 1) generates a digital signature using the requested data A. It may do this by the sub-steps of hashing the requested data A to form a hash result A' (step 3.1), and then encrypting it with the private key K (step 3.2). The host then transmits the data, the digital signature and the public key Z to the host (step 4).

10

The host uses the public key and the requested data A to verify that the requested data A matches the digital signature (step 5). For example, it can do this by using the requested data A to generate a hash result B', and decrypting the digital signature using the public key Z to form a result C'. If B' is equal to C', then this indicates that the data is correctly received. A hacker will not be able to fool the host unless he can modify A while keeping still keeping it such that it is still consistent with the digital signature (and still meeting any other predetermined characteristics – e.g. if A is a file which is intended to operate with an application, the host will be able to detect the modification if the file it receives is not compatible with that application), which in general is an extremely difficult computational task. Most modifications of A which keep its hash value will change its characteristics in other ways, e.g. make it meaningless in the context for which it is intended.

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To make this yet more difficult, optionally the public key and the file A may be transmitted separately, e.g. at times spaced apart by at least a predetermined interval.

30

3. Enhanced version of the second mode of operation of the device

A variation of the second mode of operation of the device has the additional features that the host generates a public key I and private key Z. Specifically, the sequences of steps may be as follows:

- 5 1. The device generates a public Key X and a private Key Y
2. The host generates a public Key I and private Key Z.
3. The device send the public Key X to host
4. The host send the public Key I to device
5. The device hashes the message A to A'
- 10 6. The device encrypts A' using private Key Y to produce digital signature
7. The device again encrypt both the data A and the digital signature with the public key I, and sends the encrypted data A and the digital signature to the host.
- 15 When the host receives this data it performs the following steps:
 1. The host will decrypt the digital signature with private Key Z to produce A and the digital signature. (Only the host can do this decrypt, since only it has private Key Z)
 2. The host will Hash the data with the message.
 - 20 3. The host will decrypt the digital signature with public Key X, if the result is a match then the data has not been altered.

Therefore no hacker can hack the message since they cannot even access the original message A. Furthermore, this scheme provides an additional level
25 of security compared a scheme in which the generation of the keys X and Y is omitted.

4. Biometric digital signatures

Another possible refinement of the second mode of operation of the device is that the data A may be supplemented with data which is not necessarily taken from the memory 3. In particular, it may be supplemented with biometric data received by the biometric sensor 7. Thus, this data too may be securely
5 transmitted to the host (in the sense that the host can verify that it has received exactly the biometric data transmitted by the device), and the host can verify that it matches biometric data to which the host has access.

This is particularly convenient because it means that the host can verify both
10 that the message transmitted is what the device sent, and also that the individual who sent the message is the individual with whom the host expected to transact.

We now turn to two optional modes of operation which may be present in
15 some embodiments of the invention, but which do not employ the generation of private/public keys in the device.

1. Verification of identity of host

20 In this case, the device is provided with a pre-stored public key associated with an authority (e.g. the manufacturer of the device). The public key is part of a public key/private key pair associated with the authority, but the device does not know the private key. Upon connecting the device to a host, the device receives from the host a data set produced using the private key of the
25 authority. The device is arranged to use the authority's public key to verify that the data set was produced using the authority's private key (this can be done using known techniques). Only once this is done will the device operate under the control of the host. For example, the device may contain an admin area of the memory 1, and may only modify the admin area upon instructions
30 received from a host of verified identity.

2. Verification of identify of the user

In this case, the device is provided with a pre-stored private key associated
5 with a user. The public key is part of a public key/private key pair associated
with the user. Upon connecting the device to a host, the device transmits to
the host a data set produced using the private key of the user. The host is
arranged have access to the user's public key, and to use the user's public
key to verify that the data set was produced using the user's private key (this
10 can be done using known techniques). Only once this is done the host will
operate under the control of the device. For example, the host may be a
computer arranged to perform a transaction such as a financial transaction,
and the host may only perform the transaction under the control of a device of
which the identity is verified as described above.

15

Although only a single embodiment of the invention has been described many
variations are possible within the scope of the invention as will be clear to a
skilled reader.

20 For example, whereas in Fig. 2 and Fig. 3, the public/private keys are
generated together during the method steps, in principle the integrated circuit
13 could generate public/private key pairs in advance, and the MCU 1 could
store them for example in the memory 3 until required. This would mean that
the MCU 1 would be able to access them as required from the memory, rather
25 than generate them as part of the sequence of steps of Fig. 2 or Fig. 3.

Claims

1. A portable data storage device comprising:
a non-volatile memory for storing user data,
an interface section for receiving data from and transmitting data to a
5 host,
a master control unit for transferring data to and from the non-volatile
memory, and
integrated circuit means for generating at least one key,
the device being arranged, upon receiving a command from a host
10 requesting data, to transmit the requested data stored in its memory to the
host using the interface section, and to transmit a key generated by the
integrated circuit means to the host using the interface section.
2. A device according to claim 1 in which the generated key is transmitted
in a form encrypted using a secret key which is permanently stored in the
15 portable storage device, the portable storage device further being arranged to
verify a digital signature generated by the host using the generated key and
the requested data.
3. A device according to claim 2 in which the digital signature is produced
by hashing the received data to generate a hash result, and encrypting the
20 hash result using the generated key.
4. A device according to any preceding claim in which the generated key
is one key of a public key/private key pair.
5. A device according to claim 4 in which the verification of the digital
signature is performed in the device using the public key.

6. A device according to claim 1 in which the integrated circuit means is arranged to generate the generated key as one of a public key and a private key, the device being further arranged to generate a digital signature using the requested data and the private key, and transmits the digital signature and the public key out of the device.
7. A device according to claim 6 in which the requested data includes both data present in the memory, and also biometric data obtained from a biometric sensor of the device.
8. A device according to any preceding claim arranged to transmit the requested data in an encrypted form.
9. A device according to any preceding claim comprising a biometric sensor and verification engine for granting access to data stored in the device based on a biometric verification of the user's identity by comparison of biometric data received using the biometric sensor with pre-stored biometric data.
10. A device according to any preceding claim including a compression algorithm for exploiting any redundancy in data received by the device to compress it before storing it in the non-volatile memory, and a decompression engine to regenerate the data before it is transmitted from the device.
11. A device according to any preceding claim in which the interface section include a USB connector and a USB interface device.
12. A device according to claim 11 in which the connector is a USB plug integral with the memory device.
13. A device according to claim 12 in which the interface section is for wireless communication with a host.

14. A device according to any preceding claim having a housing, the including a narrowed end for use as a pointer.

15. A device according to any preceding claim further including a camera for generating image data, and/or a microphone for capturing audio data, the
5 master control unit being arranged to store the image data and/or audio data in the memory.

16. In combination, a portable data storage device according to any preceding claim and a host computer, the host computer being arranged to transmit a command to the device using the interface section to request data.

10 17. A combination according to claim 16 wherein the device is according to claim 2, the host being arranged to generate a digital signature using the private key and the requested data.

18. A combination according to claim 16 wherein the device is according to claim 6, the host being arranged to use the public key to verify that the
15 requested data it receives is the same data which the device used to generate the digital signature.

19. A method of transferring data from a portable data storage device to a host, the method comprising:

receiving an instruction from a host requesting data stored in a non-
20 volatile memory of the device;

generating at least one key within the device;

obtaining the requested data from the non-volatile memory within the device; and

transmitting to the host the requested data and the key.

20. A method according to claim 19 in which the generated key is transmitted in a form encrypted using a secret key which is permanently stored in the portable storage device, the portable storage device further being arranged to verify a digital signature generated by the host using the generated key and the requested data.
21. A method according to claim 20 wherein the host generates a digital signature using the private key and the requested data.
22. A method according to claim 20 or 21 in which the digital signature is produced by hashing the received data to generate a hash result, and encrypting the hash result using the generated key.
23. A method according to any of claims 19 to 22 in which the generated key is the private key of a public key/private key pair.
24. A method according to claim 23 in which the verification of the digital signature is performed in the device using the public key.
25. A method according to claim 19 in which the generated key is generated as one of a public key and a private key, the method further comprising the device generating a digital signature using the requested data and the private key, and transmitting the digital signature and the public key out of the device.
26. A method according to claim 25, further including the host using the public key to verify that the requested data it receives is the same data which the device used to generate the digital signature.
27. A method according to claim 25 or 26 in which the requested data includes both data present in the memory, and also biometric data obtained from a biometric sensor of the device.

28. A method according to any of claims 19 to 27 in which the requested data is transmitted from the device to the host in an encrypted form.

29. A method according to any of claims 19 to 28 further comprising verifying the user's identity by comparison of biometric data received using the biometric sensor with pre-stored biometric data, and upon this verification for granting access to data stored in the device.

30. A method according to any of claims 19 to 29 including:

the device receiving data from the host, the device exploiting any redundancy in data to compress it, and the device storing it in the non-volatile memory; and

upon the data being requested by the host regenerating the data and transmitting it from the device.

AbstractPortable Data Storage Device with Encryption System

A portable data storage device has a non-volatile memory 3 for storing user data, an interface section 7 for receiving and transmitting data to a host, and a master control unit 1 for transferring data to and from the non-volatile memory 3. The portable data storage device further includes an integrated circuit 13 for generating a public/private key pair. The portable data storage device is arranged to transmit at least one of the keys out of the device. In different embodiments, the host can verify that the data it receives is correct, and the device can verify that the host has received the correct data.

[Fig. 1]

1/3

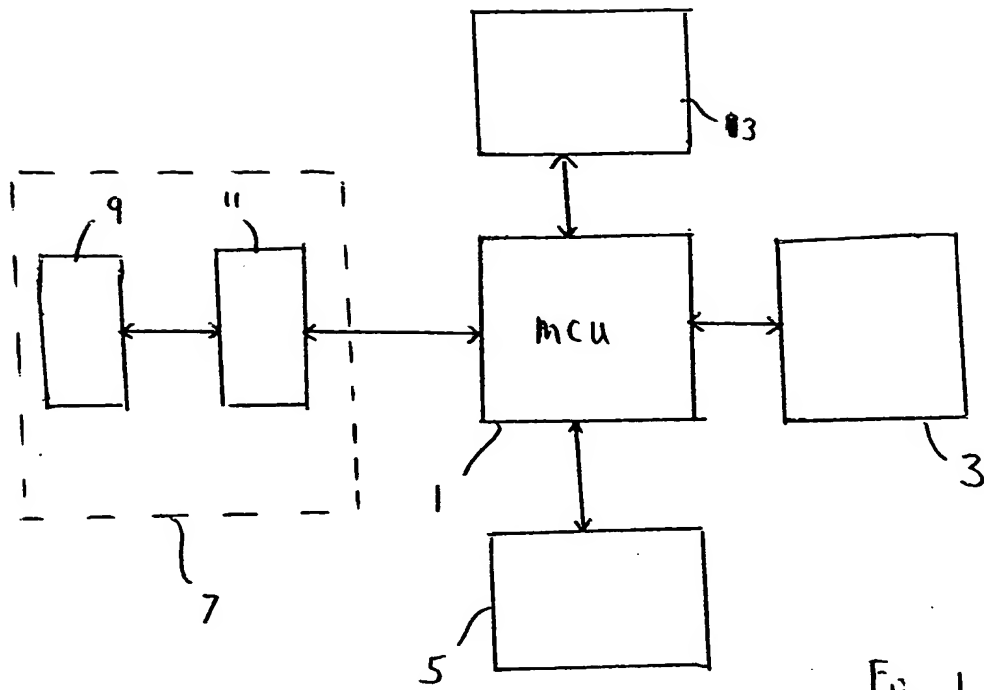
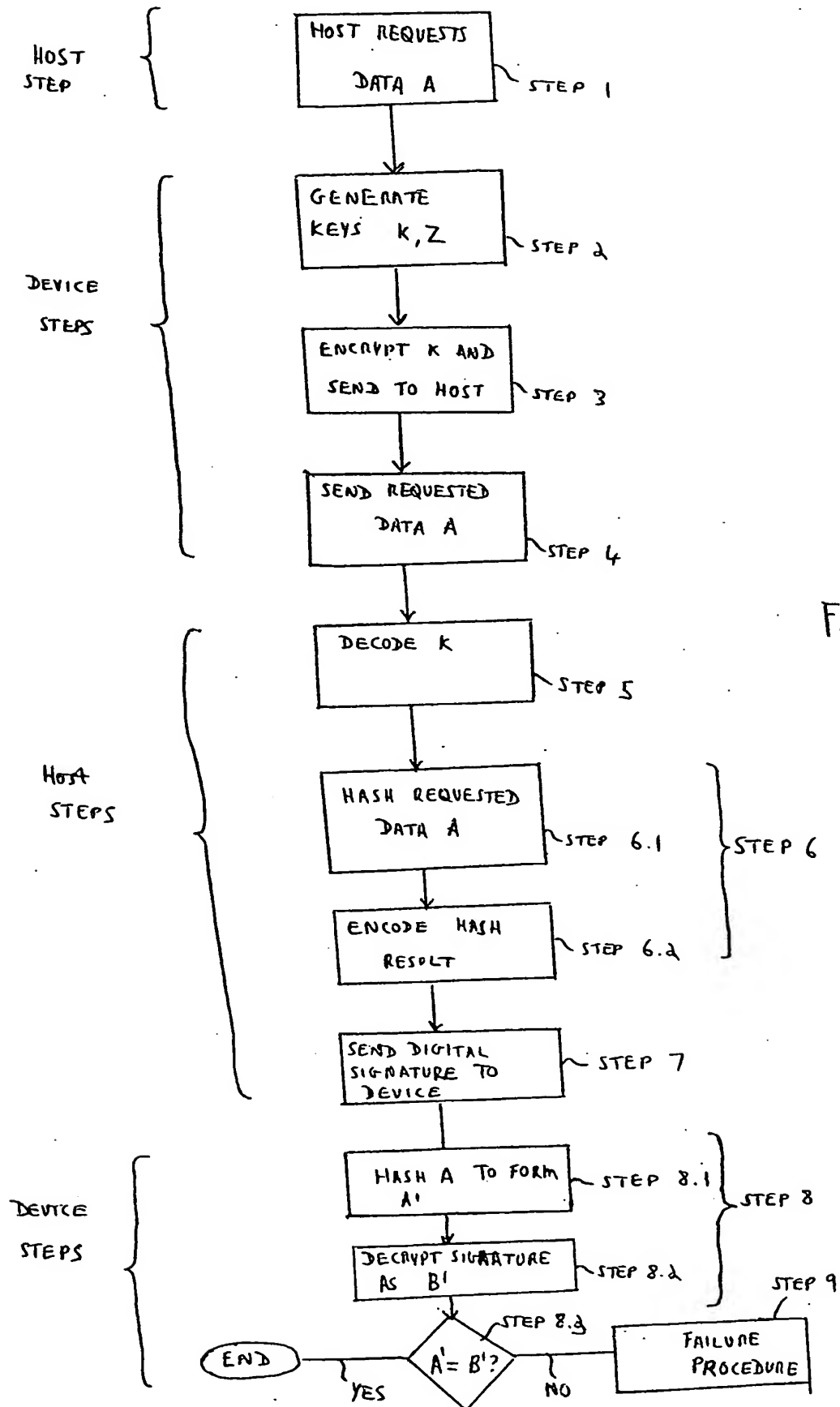


Fig. 1

2/3



3/3

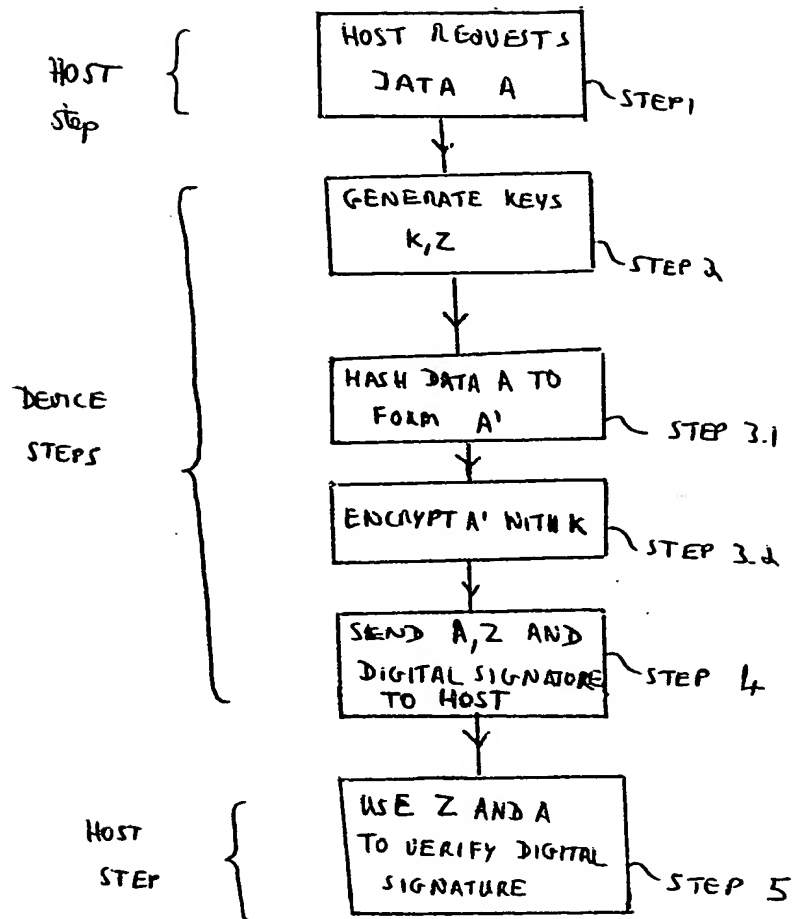


Fig. 3

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